Developing Instrumentation for Ground and Balloon-Borne Observing Platforms

Completed Technology Project (2011 - 2015)

Project Introduction

In my research I will focus on developing hardware and software technology for two instruments searching for polarization in the Cosmic Microwave Background (CMB). The CMB is light leftover from events immediately following the Big Bang. The polarization of the CMB is expected to be linear; the standard model of cosmology predicts no circular polarization. The linear polarization comes in two flavors, the E-mode polarization and the B-mode polarization. The E-mode polarization is the curl-free mode, and has been detected by experiments. The B-mode polarization is the divergence free component of the CMB, and its measurement is an important goal of observational cosmology. For example, a measurement of B-mode polarization could determine the energy scale of inflation. The B-mode polarization has never been measured. In order to develop technology for future space-flight missions to study the CMB, hardware and software must be developed and proven on ground and balloon-borne experiments. My research will work towards the advancement of these technologies in order to pave the way for the next generation of CMB satellite experiments. Successfully flying new technology in balloon payloads allows for rapid achievement of NASA TRL 7 for significantly reduced costs compared to a satellite flight. My work will include designing and building instrumentation as well as analyzing data for the E and B Experiment (EBEX). EBEX is a balloon-borne CMB polarimeter designed to measure the CMB. I am involved in a number of aspects of EBEX. I am responsible for the computer-aided design (CAD) modeling and management of the EBEX gondola. I am also working on the attitude control system. In particular I am designing a new sun sensor to provide coarse attitude determination. Brown University also built the star cameras, which provide the absolute fine pointing of the EBEX telescope, and I am also in involved with their hardware and software development. Over the next year I am going to work with the EBEX collaboration in the field at Nevis lab and the NASA Columbia Scientific Balloon Facility integrating the entire instrument in preparation for the first science flight in Antarctica. After the science flight, I will analyze the EBEX data and write my doctoral thesis with both my hardware and data analysis contributions. In addition to my work with EBEX, I am also going to continue to develop hardware for Millimeter-wave Bolometric Interferometer/QU Bolometric Interferometer for Cosmology (MBI/QUBIC) collaboration. MBI is a novel interferometer designed to search for the CMB B-mode polarization. It combines advanced bolometer technology with the improved systematics of interferometry. The MBI optical combiner technology is a novel design that is scalable from a balloon-borne, ground-based or space-flight sized instrument. Once a ground-based QUBIC instrument is developed and proven, a larger and more sensitive instrument of similar design would be an excellent candidate for a CMB space-flight mission.

Anticipated Benefits

In order to develop technology for future space-flight missions to study the

Project Image Developing Instrumentation for Ground and Balloon-Borne Observing Platforms

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Responsible Program:

Space Technology Research Grants

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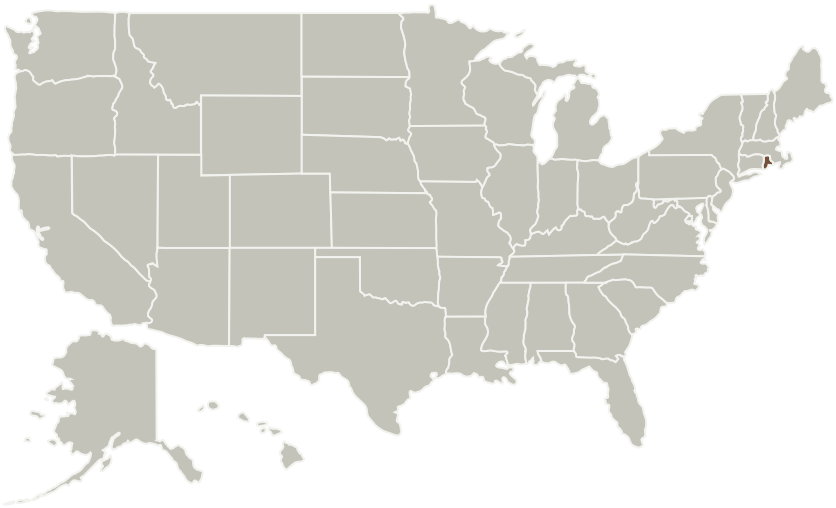
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Brown University	Supporting Organization	Academia	Providence, Rhode Island

Primary U.S. Work Locations
Rhode Island

Project Management

Program Director:
Claudia M Meyer

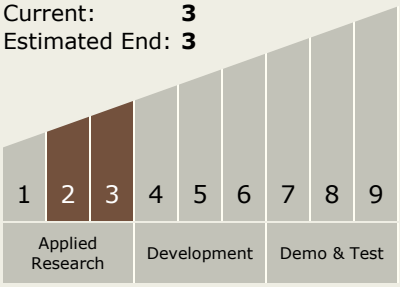
Program Manager:
Hung D Nguyen

Principal Investigator:
Gregory A Tucker

Co-Investigator:
Kyle R Helson

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX06 Human Health, Life Support, and Habitation Systems
  - TX06.3 Human Health and Performance
    - TX06.3.3 Behavioral Health and Performance

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Images

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Project Image Developing Instrumentation for Ground and Balloon-Borne Observing Platforms
(https://techport.nasa.gov/image/1742)

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html